ANNUAL REPORT

OF THE

ARIZONA GEOLOGICAL SURVEY

FY 2003

Sunset Crater, from *A Guide to the Geology of the Flagstaff Area*,
Arizona Geological Survey, Down-to-Earth 14.

Larry D. Fellows
Director and State Geologist

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Janet Napolitano
Governor

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Director and State Geologist

September 9, 2003

The Honorable Janet Napolitano
Governor
1700 W. Washington
Phoenix, AZ 85007

Dear Governor Napolitano:

It is my pleasure to submit this Annual Report of the Arizona Geological Survey (AZGS) for FY 2003. AZGS geologists map and characterize the geology of Arizona to help meet societal needs for water, energy, and mineral resources and assist in the prudent management of Arizona's land and natural resources. During FY 2003 they completed the following projects:

- Mapped and described rock and related units in the Phoenix-Tucson corridor
- Identified flood-prone areas on desert piedmonts in Maricopa County
- Studied ancient floods along the Verde River in central Arizona
- Studied the earthquake hazard related to the Hurricane fault in northern Arizona
- Studied the relationships among fires, soil geochemistry, and geomorphology at Fort Huachuca
- Monitored and mapped land subsidence and earth fissures caused by overpumping groundwater in central and southern Arizona
- Studied rocks that contain mineral and energy resources in the Holbrook basin

As a primary source of information on Arizona geology, the AZGS answered requests for information, sold geologic maps and reports, gave talks, and led fieldtrips.

This report includes summaries of these and other projects and activities. I'll gladly answer any questions you or your staff might have about the report, the Arizona Geological Survey, or the geology of Arizona, in general.

Respectfully submitted,

Larry D. Fellows
Director and State Geologist

EXECUTIVE SUMMARY

Arizona Geological Survey (AZGS) employees informed and assisted the public during Fiscal Year 2003 as follows:

Answered questions from thousands of people who wrote, telephoned, e-mailed, or visited our office to obtain information or advice about the geology of Arizona, including the distribution and character of rock formations and their weathering products, mineral and energy resources, and geologic hazards and limitations to land and resource management.

Sold more than 8,300 geologic reports and maps. (Ninety-four percent of mail orders were filled and returned the same day they were received.) Publication sales totaled $63,125.

Provided special assistance requested by 23 governmental agencies, professional societies, university departments, and other groups by giving talks, conducting workshops, leading fieldtrips, reviewing manuscripts, advising students, serving as officers or committee members, and doing related activities

Participated in nine cooperative projects, seven of which were done under contract with governmental agencies including the Arizona State Land Department, Department of Water Resources, Flood Control District of Maricopa County, National Park Service, U.S. Army, U.S. Forest Service, and U.S. Geological Survey. Expenditures from contracted projects totaled $462,709. AZGS staff supervised the work of 21 temporary and part-time employees who were paid with contract funds to complete the projects.

Released 28 new reports and maps on Arizona geology, including:

- Twenty geologic quadrangle maps, 10 of which were in the Phoenix-Tucson corridor (all were made available to the public in digital and paper format).

- Two applied geology studies, one on salt and other resources in the Holbrook basin the other on naturally occurring radioactive materials.

- Four articles on Arizona geology in professional journals and other external publications.

Published four 6-page issues of *Arizona Geology*, the quarterly newsletter of the AZGS.

CONTENTS

MISSION AND DESCRIPTION

MISSION

To inform and advise the public about the geologic character of Arizona to help meet societal needs for water, energy, and mineral resources and assist in prudently managing the State's land and natural resources.

DESCRIPTION

To carry out the mission, AZGS staff prepare geologic maps, complete field studies, compile data, and disseminate information. Staff members perform the following functions:

- **Geology for Societal Needs.** Map and characterize rock units and their weathering products. Investigate geologic hazards and limitations such as earthquakes, land subsidence, flooding, and rock solution that may affect the health and welfare of the public or impact land and resource management. Describe the origin, distribution, and character of metallic, non-metallic, and energy resources and identify areas that have potential for future discoveries.

- **Information and Service.** Inform and assist the public by answering inquiries, preparing and selling maps and reports, maintaining a library and databases, maintaining a website, giving talks, and leading fieldtrips.

- **Oil and Gas.** Provide administrative and staff support to the Arizona Oil and Gas Conservation Commission, which regulates the drilling for and production of oil, natural gas, geothermal, helium, and carbon dioxide to ensure that sound engineering, environmental, and conservation practices are followed.

Geologic Data Users: Citizens and citizen groups; elected officials and their staff, land- and resource-management agencies (e.g. State Land Department, Department of Water Resources, Department of Environmental Quality, Department of Transportation, State Parks, Office of Tourism, Attorney General, U.S. Bureau of Land Management, U.S. Forest Service), environmental and engineering geology companies, hydrologists, energy- and mineral-exploration companies, consultants, attorneys, realtors, insurance companies, teachers, students, libraries, book dealers, and others.

GOAL 1. GEOLOGY FOR SOCIETAL NEEDS

To increase knowledge of Arizona's geologic character, resources, and hazards with emphasis on areas that have potential for population growth and resource discovery and development.

Objective 1. Submit National Geologic Mapping Program deliverables on time.
Result: Accomplished objective – completed and submitted 9 geologic quadrangle maps on time and within budget.

Objective 2. Finish two applied geology projects (hazards; mineral/energy resources).
Result: Accomplished objective.

Objective 3. Improve the quality of geologic maps and reports released.
Result: Accomplished objective – customers rated quality of products 4.8 (scale of 1-5, 5 best), up from 4.7 in FY 2002.

GOAL 2. INFORMATION AND SERVICE

To increase publication sales and maintain high quality of service.

Objective 1. Increase sale of geologic maps and reports by five percent.
Result: Sold 1,388 fewer maps and reports (13 percent decrease).

Objective 2. Maintain or improve quality of service provided.
Result:Accomplished objective – customers rated satisfaction with service 4.9 (scale 1-5, 5 best), the same as for FY 2002.

Objective 3. Release two nontechnical reports.
Result:Released one report (Guide to the geology of the Flagstaff area) and one poster map (Arizona Rocks).

GOAL 3. OIL AND GAS CONSERVATION COMMISSION

To effectively assist the Arizona Oil and Gas Conservation Commission.

Objective 1. Respond to requests for drilling permits within 5 working days.
Result:Accomplished objective – issued 1 permit to drill with a 4-day turn-around time.

Objective 2. Inspect gas-storage wells twice during year.
Result:Accomplished objective - conducted safety inspections of 14 wells in November and April.

GEOLOGY FOR SOCIETAL NEEDS

Geologic mapping in the Phoenix-Tucson corridor. AZGS geologists have been mapping bedrock and surficial geology in urban fringe areas in Arizona for the past decade. Mapping has been completed in most of the Phoenix-Tucson corridor. In the past year, the AZGS released maps of seven 7.5-minute quadrangles in the Tortolita Mountains and adjacent areas north of Tucson (Digital Geologic Maps 18-23, 26), and two quadrangles in the Buckeye Hills west of Phoenix (Digital Geologic Maps 15,16).

Geologists are currently mapping on the southwestern edge of Tucson and in the San Pedro Valley between Benson and Ft. Huachuca. Mapping is also being done in Rainbow Valley on the southwestern fringe of the Phoenix area to provide preliminary floodplain information.

Funding for geologic mapping is from the Statemap Component of the National Cooperative Geologic Mapping Program, administered by the U.S. Geological Survey. The award for FY 2003 is $235,000, which is matched equally by the AZGS in in-kind service. Mapping priority areas are determined by the Arizona Geologic Mapping Advisory Committee, which is composed of representatives of State land- and resource-management agencies and the private sector.

Digital map data. One of the purposes of the National Cooperative Geologic Mapping Program is to complete a digital geologic map database for the nation. The AZGS participated in North American Geologic Map Data Model activities undertaken by the Association of American State Geologists and the U.S. Geological Survey. S.M. Richard is a member of the North American Data Model Steering Committee, which coordinates and reviews efforts to develop a data model, science language, and interchange mechanisms for exchange of geologic map data among state and federal geological survey data providers and data consumers in the public and private sector.

Richard is also a member of a workgroup to develop a standard digital geologic map data model. Version 1.0 of model is in final review by the workgroup. After this review has been completed, the workgroup will post the model on the web for public comment.

In addition, Richard serves on the workgroup to develop a standard list of science language terms for metamorphic rocks. A proposal for a database classification scheme for metamorphic rocks was completed and submitted to the North American Data Model Steering Committee for review.

Piedmont flood hazards. The AZGS has cooperated with local floodplain-management agencies to prepare geologic maps to help define flood-prone areas on desert piedmonts for the past 15 years. Active alluvial fans, where floodwater spreads widely and new channels may form during floods, are the areas of primary concern.

P.A. Pearthree provided information to the Flood Control District of Maricopa County about the use of surficial geologic mapping in delineating flood hazards on desert piedmonts. The AZGS is currently mapping the surficial geology of the Waterman Wash watershed in Maricopa County to help delineate piedmont flood hazards there.

Ancient floods along the Verde River. AZGS geologists, in collaboration with researchers at the University of Arizona and the U.S. Bureau of Reclamation, began investigating the flood history of the Verde River in central Arizona following the two large floods of 1993. Geologists are preparing a summary report on the results of paleoflood investigations at four sites. Studies show that although the historical floods of 1891 and 1993 were among the largest in the last few thousand years, one somewhat larger flood occurred in the last 300 years.

Earthquake hazards associated with the Hurricane fault in northwestern Arizona. Geologists from the Utah Geological Survey, Arizona State University, and the AZGS have collaborated on an investigation of the recent history of the Hurricane fault in northern Arizona for several years. The Hurricane fault in Arizona, which has produced several magnitude 6.5 to 7 earthquakes in the past 15,000 years, definitely has potential to cause damage between the western Grand Canyon and Cedar City, Utah. AZGS geologists, in cooperation with researchers at the University of Utah and the USGS, found evidence that movement on the Hurricane has had a major influence in development of Grand Canyon during the past few million years.

8 **Naturally occurring radioactive materials.** In response to a request for information about "Naturally Occurring Radioactive Materials" (NORM) from a committee of the Arizona Mining Association, J.E. Spencer prepared a summary report. The report, released as Open-File Report 02-13, includes a definition NORM and a brief discussion of six rock units in Arizona that contain elevated concentrations of uranium. The report was summarized in *Arizona Geology* (v. 33, n. 2).

Fires, soil geochemistry, and geomorphology in southeastern Arizona. The AZGS has cooperated with the U.S. Forest Service on several projects to provide geologic mapping and other data used to support sustainable range-management practices in southeastern Arizona. During the past year AZGS geologists sampled soils on burned and unburned areas at Ft. Huachuca, and are now mapping the surficial geology of the burned areas. The soil samples will be chemically analyzed. Geologists will submit a report and maps to the U.S. Forest Service and Fort Huachuca staff that describe the relationships among soil geochemistry, burned areas, and geomorphology.

INFORMATION AND SERVICE

Earth Science Information Center. Staff, primarily Thomas G. McGarvin and Richard A. Trapp, answered requests for information about Arizona geology. Other staff, primarily Mary N. Andrade and Rachel A. Aragon, sold reports and maps and answered inquiries. They filled and mailed ninety-four percent of mail orders the same day the orders were received. The AZGS has formal agreements to distribute Arizona Geological Society and the U.S. Geological Survey publications.

Publication sales totaled $63,125, which was down from $73,089 in FY 2002. The decline in sales is attributed to the sluggish economy. Revenue from publication sales is used to purchase products for resale and to print and distribute publications.

Geology library and databases. The AZGS maintains a non-circulating library that contains the following published and unpublished items: U.S. Geological Survey publications, maps, and open-file reports; theses and dissertations on Arizona geology; reports by Arizona state agencies; and publications of the state geological surveys in adjacent states. The library, managed by Thomas G. McGarvin, is open to the public.

AZGEOBIB is a database that contains more than 13,000 bibliographic citations on Arizona geology. The database is key-worded by subject and geographic area. AZGS staff members provide lists of citations for specific requests. This is a popular service for those who are starting new projects and need to know what geologic maps and reports are available in the project area. Richard A. Trapp, IT Manager, maintains the databases.

Web site. The AZGS web site (**www.azgs.az.gov**) includes information about the agency, geology of Arizona, and publications for sale. The state geologic map, geologic hazards, and links to other geology-related agencies and groups are provided. Rose Ellen McDonnell is the webmaster.

***Arizona Geology*.** The AZGS published four six-page issues of *Arizona Geology* to describe events related to geology, publicize new geologic maps and reports, and to highlight other activities that pertain to geology in Arizona. Feature articles described known and potential geologic hazards in Arizona, geologic aspects of construction aggregate, procedures to follow when drilling an oil or gas well, distribution of naturally occurring radioactive materials, and correlation of rocks in the Holbrook basin with those on outcrop at Sedona and Grand Canyon.

Down-to-Earth (DTE) publications. These publications are written for those who have had no formal education or training in geology. DTE 14, *A guide to the geology of the Flagstaff area*, was released. It includes descriptions and color photographs of 23 geologic features in the Flagstaff area, including within Sunset Crater, Wupatki, and Walnut Canyon National Monuments and Meteor Crater. This was the sixth book that has been done in collaboration with John V. Bezy, a National Park Service geologist.

Earth science education. Thomas G. McGarvin, the primary AZGS contact with science and earth science teachers, assisted teacher groups in incorporating local geology in their courses. McGarvin conducted geology workshops for the Arizona Association for Environmental Education and at the annual meeting of the Arizona Science Teachers Association. He also led a field trip for the Tucson Unified School District, D.T. Smith Science Center.

Rock cuttings and core repository. The AZGS maintains a repository containing cuttings from more than 4,000 oil and water wells, and cores from a number of energy and mineral exploration drill holes. The cuttings, core samples, and well logs are available for examination and research by the public.

10 **Service to community and professional groups.** AZGS geologists participated in a variety of activities, including serving as officers or committee members, giving talks, leading fieldtrips, conducting workshops, serving on panels, reviewing applications or proposals for funding, and reviewing manuscripts submitted for publication as follows:

Arizona Floodplain Management Association: led field trip
Arizona Geological Society: served as President, Past President, Councilor, and Chair of the Courtright Scholarship Committee; gave talk
Arizona Hydrological Society: served as Treasurer
Arizona Mining Association: prepared report
Arizona Science Teachers Association, Annual Conference: conducted workshop
Association of American State Geologists: chaired two committees
County Supervisors Association of Arizona: gave talk
European Science Foundation: reviewed proposal
Friends of the Pleistocene and Arizona Geological Society: led field trip
Geological Society of America: reviewed manuscript
National Science Foundation: reviewed five proposals
Pima Community College, Green Valley Campus: gave talk
Pima County Flood Control District Advisory Committee: served as Vice-chair
Raytheon Rockhounders: gave talk
Tohono Chul docents: conducted workshop
Tucson Gem and Mineral Society: served on gem show committee
Tucson Welcome Wagon alumni: gave talk
U.S. Forest Service, Sabino Canyon Recreation Area: gave talk
U.S. Geological Survey: served on advisory panel
University of Arizona, Department of Geosciences: served on Ph.D. advisory committee; gave talk
Western National Parks Association: gave two talks
Wings Over Willcox: led three fieldtrips
Verde River Day, Cottonwood: led two fieldtrips

OIL AND GAS CONSERVATION COMMISSION

Oil and Gas Conservation Commission (OGCC). The OGCC regulates the drilling for and production of oil, gas, helium, carbon dioxide, and geothermal resources. The Governor appoints five members of the commission. The sixth member, the State Land Commissioner, is *ex officio*. Commissioners are J. Dale Nations, Tucson, chairman; Robert L. Jones, Sun City West, vice chairman; Joseph J. Lane, Phoenix; Michele P. Negley, Phoenix; Robert L. Wagner, Yuma; and Mark Winkleman, State Land Commissioner. The Commission held three meetings.

The OGCC is attached to the AZGS, which provides administrative and staff support. Staff issue permits to drill, monitor drilling, inspect completed wells, compile drilling and production data, and maintain well files. Steven L. Rauzi is the Oil and Gas Administrator.

Production, refining, and storage. Oil production in calendar year (CY) 2002 totaled 63,417 barrels from 20 producing wells, up from 60,297 barrels from 23 wells in 2001. Gas production in CY 2002 totaled 304 million cubic feet from seven producing gas wells, down from 307 million cubic feet from eight wells in 2001. CO_2 production totaled 217 million cubic feet from one producing well in 2002. Commercial production of CO_2 started in July 2002.

Both of Arizona's refineries remained closed. The refineries, near Fredonia and Coolidge, have been shut down since January 1997 and August 1993, respectively.

Liquefied petroleum gas (LPG) transferred in CY 2002 through storage wells near Luke Air Force Base and Adamana included 90 million gallons in receipts and 122 million gallons in deliveries. In CY 2001, 127 million gallons were received and 107 million gallons were delivered. About 29 million gallons of LPG were in storage at yearend, down from the 60 million gallons the previous year. Fourteen storage wells constructed in subsurface salt are currently in use.

Leasing. In CY 2002, 438,000 acres were under lease for oil and gas exploration, up from 381,000 acres under lease in CY 2001.

State Trust land under lease in December 2002 totaled 324,000 acres, up from 274,500 acres in December 2001. Public land under lease in December 2002 totaled 114,000 acres, up from 106,500 acres in December 2001. The State Land Department administers leasing on State Trust Land. The U.S. Bureau of Land Management administers leasing on public lands.

Drilling. One permit to drill was issued and two holes were drilled in FY 2002-03. Copper Eagle Gas Storage, LLC drilled two stratigraphic holes to test sedimentary units adjacent to and below a large salt deposit near Luke Air Force Base. The Copper Eagle holes are temporarily abandoned.

Inspection and enforcement. Staff made semiannual inspections of 14 hydrocarbon-storage wells near Luke Air Base and Adamana and witnessed the cementing of surface casing on the two stratigraphic holes drilled near Luke Air Force Base. Inspections are conducted to ensure that all wellhead valves, safety alarms, and emergency shutdown systems are in good working condition and that cement is circulated back to the surface when the surface casing is being set.

Carbon dioxide update. Ridgeway Arizona Oil Corporation announced a discovery of carbon dioxide (CO_2) southeast of St. Johns in southern Apache County in August 1994. The company drilled 15 wells by June 1997. At the end of FY 2002 two wells had been completed as gas wells; seven were temporarily abandoned; and six were plugged and abandoned. The company did no drilling in FY 2003.

In 1999 Ridgeway representatives stated that initial development to supply CO_2 for enhanced oil recovery would require two to three years and about 200 wells. The company estimated that as many as 1,195 wells would eventually be drilled over the 25-40 year life of the project. In 2000 the company announced that it planned to begin producing liquid carbon dioxide from a facility supplied by gas from three wells, two in Arizona and one in New Mexico, in about five months. The company began producing CO_2 from one well in July 2002. All production is piped to a liquids plant at the Tucson Electric Power Company's Springerville Generating Station.

PERSONNEL[1]

12 Office of the Director

Larry D. Fellows, Director and State Geologist
B.S., Iowa State University; M.A., University of Michigan;
Ph.D., University of Wisconsin

Rose Ellen McDonnell, Assistant Director of Administration
B.S., University of Arizona

Geologists

Jon E. Spencer, Senior Geologist
B.S., University of California, Santa Cruz;
Ph.D., Massachusetts Institute of Technology

Thomas G. McGarvin, Geologist II
B.A., California Lutheran College

Erin M. Moore[2]**,** Geologist I
B.S., University of Arizona, M.S., University of California at Davis

Tim R. Orr[3], Geologist II
B.S., University of Montana; M.S., Northern Arizona University

Philip A. Pearthree, Research Geologist
B.A., Oberlin College; M.S., University of Arizona;
Ph.D., University of Arizona

Steven L. Rauzi, Oil and Gas Administrator
B.S. and M.S., Utah State University

Richard A. Trapp, Information Technology Manager
B.S., University of Nebraska, Omaha; M.S., University of Arizona

Support Staff

Mary E. Redmon, Administrative Assistant III
Mary N. Andrade, Administrative Assistant I
Rachel A. Aragon, Secretary
John A. Birmingham[4], Program and Project Specialist II
B.A., University of Arizona

Contracted Geologists and Student Assistants[5] 13

Monisha J. Banerjee, Laboratory Technician
Thomas H. Biggs, Research Geologist
Megan E. Brown, Research Assistant II
Stephen B. DeLong, Project Geologist
Charles A. Ferguson, Research Geologist
Noah E. Egge, Research Assistant II
Lisa N. Florkowski, Research Assistant II
Raymond C. Harris, Geologist II
Kevin C. Horstman, Research Geologist
Bradford J. Johnson, Research Geologist
Vena Jones, Project Geologist
Andrew H. McLeod, Geologist
Erin M. Moore, Geologist I
Christopher C. Morrison, Student Aide
Tim R. Orr, Geologist II
Stephen M. Richard, Research Geologist
Joel H. Ruiz, Student Aide
Todd C. Shipman, Geologist
Steven J. Skotnicki, Geologist II
Morley J. Weitzman, Research Geologist
Ann M. Youberg, Geologist II

(1) Geologists and support staff who were paid from the General Fund appropriation and were on the payroll on June 30, 2003, except as otherwise noted. The Arizona Geological Survey is authorized to employ 12.25 full-time-equivalent staff members from the General Fund appropriation.

(2) Hired October 16, 2002

(3) Resigned December 10, 2002

(4) Resigned November 5, 2002

(5) Paid from contracted projects funded by other agencies or groups during Fiscal Year 2003 to complete a specific product or service within an specified period of time.

EXPENDITURES

GENERAL FUND EXPENDITURES

Category	FY 2002 Expended	FY 2003 Expended	FY 2004 Budgeted
Personal Services	510,104	430,559	429,300
Benefits	95,630	89,419	85,000
Operations	214,232	213,607	219,900
In-State Travel	40,221	39,329	44,500
Out-of-State Travel	913	1,081	
Capital Equipment	19,910	775	
TOTAL	**881,010**	**774,770**	**778,700**

PRINTING REVOLVING FUND

PUBLICATIONS	FY 2003 Expended
Arizona Geological Survey	62,289
Arizona Geological Society	5,201
U.S. Geological Survey	13,145
Other Publications	4,149
TOTAL	**84,784**

CONTRACTED PROJECTS

Project Fund Source	Principal Investigator	Personal Services	Benefits	Operations	In State Travel	Other Costs	TOTAL
Geologic Mapping USGS	Spencer	152,092	28,802	23,352		23,658	227,904
Fort Huachuca Fire on Soil USFS	Pearthree	1,933	18,834	21,739	785		43,291
Tonto National Forest USFS	Spencer	8,133	1,744	35	1,269	2,782	13,963
National Geologic Database USGS	Richard	14,205	3,530	3		308	18,046
Gila Oil Well Gila Valley NRCD	Harris	747	142				889
Marsh Station Statistical Research, Inc.	Pearthree	421	54				475
Ground Resources Arizona State Land Department	Harris	108,243	19,343	1,093	38	7,395	136,112
Waterman Wash Engineering and Environmental Consultants, Inc.	Pearthree	10,238	2,014	208	521		12,981
Hydrogeomorphic Assessment US Army Corps of Engineers	Pearthree	147	16			524	687
Piedmont Flood Hazard Assessment H.W. Hjalmarson, P.E.	Pearthree	6,481	830	35			7, 346
Gamma-ray Spectrometer Survey Environmental & Earth Science Consultants	Harris	700	139	11	164		1,014
TOTAL		**303, 340**	**75,448**	**46,476**	**2,777**	**34,667**	**462,708**

16 *Arizona Geology* Articles

Buying or building? Have you considered geologic hazards?: L.D. Fellows, v. 32, n. 3, p. 1-4
Fiscal Year 2002 – summary of activities: L.D. Fellows, v. 32, n. 3, p. 5
Development devours aggregate: L.D. Fellows, v. 32, n. 4, p. 1-4
Want to drill an oil well?: S.L. Rauzi, v. 33, n. 1, p. 1-4
Hello "NORM": J.E. Spencer, v. 33, n. 2, p. 1-2
Holbrook basin: correlation and resources: S.L. Rauzi and L.D. Fellows, v. 33, n. 2, p. 3-5

Contributed Maps

CM 02-B. Structural and stratigraphic relationships of mid-Tertiary strata in the Hackberry Wash-Indian Camp Wash intramontane depression, Tortilla Mountains, Pinal County, Arizona: W.R. Dickinson, 2002, Arizona Geological Survey Contributed Map 02-B, 13 p., one sheet, scale 1:24,000.

Contributed Reports

CR 02-A. Subsurface geology of the easternmost Phoenix basin, Arizona: Implications for groundwater flow: Reynolds, S.J., and Bartlett, R.D., 2002, Arizona Geological Survey Contributed Report 02-A, one CD ROM that includes a 74-page text.

CR 02-A. Geology and hydrology of the Payson-Strawberry-Diamond Rim area, Gila and Coconino counties, central Arizona: Weitzman, Morley, 2002, Arizona Geological Survey Contributed Report 02-B, 17 p., 1 sheet, scale 1:62,500.

CR 03-A. Excursion to Gardner Canyon: Sedimentology and tectonic context of Mesozoic strata in the Santa Rita Mountains, southeastern Arizona: Dickinson, W.R., 2003, Arizona Geological Survey Contributed Report 03-A, 29 p.

CR 03-B. Subsurface geologic investigation of Fountain Hills and the lower Verde River Valley, Maricopa County, Arizona: Skotnicki, S.J., Young, E.M., Goode, T.C., and Bushner, G.L., 2003, Arizona Geological Survey Contributed Report 03-B, 43 p.

Digital Geologic Maps

DGM 15. Geologic map and report for the Buckeye 7.5' quadrangle, Maricopa County, Arizona: Skotnicki, S.J., 2002, Arizona Geological Survey Digital Geologic Map 15, 1 CD ROM that includes a 15 p. text and 1:24,000-scale geologic map.

DGM 16. Geologic map and report for the Avondale SW 7.5' quadrangle, Maricopa County, Arizona: Skotnicki, S.J., 2002, Arizona Geological Survey Digital Geologic Map 16, 1 CD ROM that includes an 11 p. text and 1:24,000-scale geologic map.

DGM 17. Digital graphics files for the Geologic Map of Arizona: A representation of Arizona Geological Survey Map 35: Richard, S.M., Reynolds, S.J., Spencer, J.E., and Pearthree, P.A., 2002, Arizona Geological Survey Digital Geologic Map 17, 1 CD ROM that includes 1 Adobe Illustrator v5.0 file and 1 jpeg image file (200 dpi).

DGM 18. Geologic map of the Fortified Peak 7.5' quadrangle, southeastern Pinal County, Arizona: Orr, T.R., DeLong, S.B., Spencer, J.E., and Richard, S.M., 2002, Arizona Geological Survey Digital Map 18, 1 CD ROM that includes a 1:24,000-scale geologic map.

DGM 19. Geologic map of the Durham Hills 7.5' quadrangle, Pinal County, Arizona: Richard, S.M., Youberg, Ann, Spencer, J.E., and Ferguson, C.A., 2002, Arizona Geological Survey Digital Geologic Map 19, 1 CD ROM that includes a 1:24,000-scale geologic map.

DGM 20. Geologic map of the Desert Peak 7.5' quadrangle, southeastern Pinal County, Arizona: Youberg, Ann, Ferguson, C.A., Richard, S.M., Johnson, B.J., Maher, D.J., and Gilbert, W.G., 2002, Arizona Geological Survey Digital Geologic Map 20, 1 CD ROM that includes a 1:24,000 scale geologic map.

DGM 21. Geologic map of the Oro Valley 7.5' quadrangle, northeastern Pima County, Arizona: Spencer, J.E., and Pearthree, P.A., 2002, Arizona Geological Survey Digital Geologic Map 21, 1 CD ROM that includes a 1:24,000 scale geologic map.

DGM 22. Geologic map of the Chief Butte 7.5' Quadrangle, southeastern Pinal County, Arizona: Spencer, J.E., Richard, S.M., Youberg, Ann, Ferguson, C.A., and Orr, T.R., 2002, Arizona Geological Survey Digital Geologic Map 22, 1 CD-ROM that includes a 1:24,000-scale geologic map.

DGM 23. Geologic map of the North of Oracle 7.5' Quadrangle, southeastern Pinal County, Arizona: Orr, T.R., Shipman, T.C., and Spencer, J.E., 2002, Arizona Geological Survey Digital Geologic Map 23, 1 CD-ROM that includes a 1:24,000-scale geologic map.

DGM 24. Geologic map of the Sierra Ancha, central Arizona: Skotnicki, S.J., compiler, 2002, Arizona Geological Survey Digital Geologic Map 24, 1 CD-ROM that includes a 29 p. text and 1:100,000-scale geologic map.

DGM 25. Geologic map of the southern Peloncillo Mountains; Skeleton Canyon, Guadalupe Spring, and Guadalupe Canyon 7.5' quadrangles, Cochise County, Arizona and Hidalgo County, New Mexico: Skotnicki, S.J., 2002, Arizona Geological Survey Digital Geologic Map 25, 1 CD-ROM that includes a 1:24,000-scale geologic map and a 26-page text.

DGM 26. Geologic map of the Tortolita Mountains, Pinal and Pima Counties, Arizona: Ferguson, C.A., Johnson, B.J., Skotnicki, S.J., Maher, D.J., Spencer, J.E., Gilbert, W.G., Richard, S.M., Youberg, Ann, Demsey, K.A., and House, P.K., 2003, Arizona Geological Survey Digital Geologic Map 26, 46 p., 2 sheets, scale 1:24,000.

DGM 27. Geologic map of a portion of the silicified Mescal paleokarst, northern Sierra Ancha, central Arizona: Skotnicki, S.J., 2002, Arizona Geological Survey Digital Geologic Map 27, 1 CD ROM that includes a 1:50,000 scale geologic map.

DGM 28. Geologic map of the Phoenix Mountains, central Arizona: Johnson, J.K, Reynolds, S.J., and Jones, D.A., 2003, Arizona Geological Survey Digital Geologic Map 28, 1 CD-ROM that includes 2 1:24,000-scale geologic maps.

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